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ABSTRACT

Many experts have predicted a global crisis for the end of the twentieth century because of dwindling supplies of natural resources such as minerals, oil, gas, and soil. This booklet considers three aspects of natural resources, time, space, and spirit. Time refers to a sense of history; space refers to geography; and spirit refers to life and thought. Several chapters on the history and concepts of natural resources utilization, a time line related to the concept, a map of the important geography related to this concept, a glossary of important terms, and a list of several study suggestions are included. (CW)

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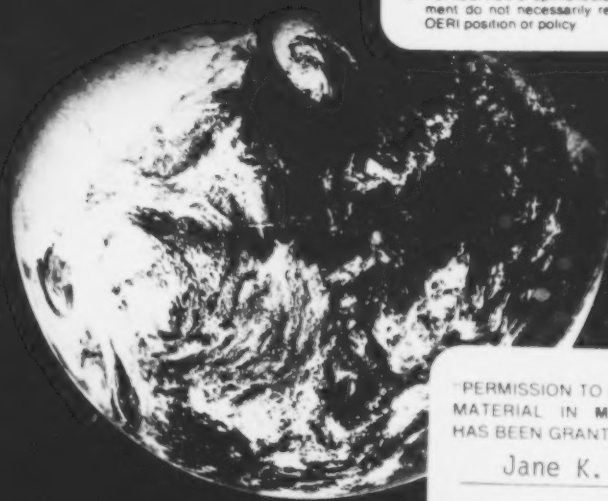
Natural Resources

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A HAWKHILL LEARNING POWER BOOK

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TIME, SPACE AND SPIRIT

KEYS TO SCIENTIFIC LITERACY

To the student,

This short book will help you understand our modern world. It has changed a lot since your parents were born. Even more since you were born. And it will change still more—much more—in your lifetime.

What is behind most of these big changes? Two things. Science and technology.

What can you do about it? The first step is to understand more about science and technology and how they connect with our world. Especially the ever-growing world of free democratic societies. One way to do this—the way this book follows—is to look at the world from three angles: *Time*, *Space* and *Spirit*.

Time means history. You can learn how science and technology have worked in the past and are working today.

Space means geography. You can learn where important things happened in the past and are happening today.

Spirit means life. The life of the mind. You can learn the key words, concepts and ideas that power science and technology (and society) today.

This book teaches about science, technology and society from all three of these angles—*Time*, *Space* and *Spirit*.

Read on.

This book belongs to:

Natural Resources

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Illustrations by Lin Haley

Hawkhill Associates
Madison, Wisconsin

This book is one of a series of sixteen Learning Power Books in the *Time, Space and Spirit—Keys to Scientific Literacy* series. It is designed to accompany the video program of the same name.

The *Time, Space and Spirit—Keys to Scientific Literacy* series was written and produced with consultation from the History of Science Department at the University of Wisconsin-Madison.

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Part 1: Doomsday or Utopia—The Record of the Past



**a natural
resource crisis**

A hundred and seventy years ago there was a major natural resources crisis. The oil that was used to light houses, factories and public buildings; the oil that was used for lubrication, making soap, varnishes and paint; the oil that was used for finishing leather and woolen products; that all-purpose oil was getting more and more scarce and more and more expensive.

**doom
predicted**

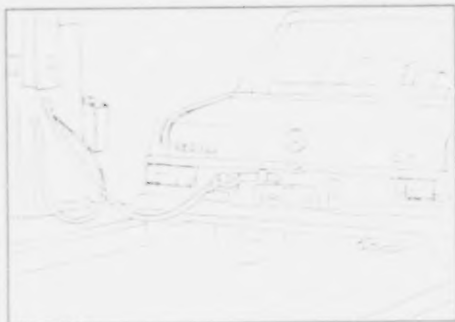
Also getting scarce and more expensive was the natural material people used then for many of the same uses we today have for plastics. With so many critically important natural resources running out, many experts predicted doom in the near future.

It didn't happen that way.

The oil was whale oil, and the natural plastic material was whale bone.

doom in our future?

Today in the final decades of the twentieth century many experts are predicting the same doom for the future as we seem to be running out of oil and

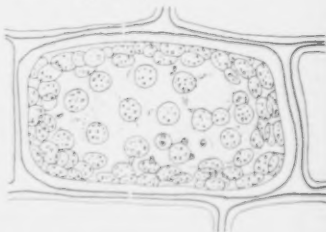


gas, of minerals and soil—while our world population continues to soar. Let's see what perspective we can gain on our natural resource problems today by looking at the history of natural resource problems in the past.

a crisis three billion years ago

One of the first natural resource crises for life on earth happened two or three billion years ago. In the ancient primordial ocean the world's first living organisms had been gobbling up the rich amino acid soup that had been made by lightning, volcanic action and other nonliving sources over many millions of years. When the soup began to get too thin to support such a large population of living organisms, many died from starvation.

Some organisms, however, had developed an ability to use direct sunlight as a source of energy and they prospered. The world of plants was born. And with them many new possibilities for life on this small planet.



many other crises

Passing through that crisis must have taken a long time. The living world, of course, passed through many other energy and raw material crises over the next three to four billion years. For our purposes let's leap forward to the first human natural resource crisis.

earth population of one or two million people

It probably happened many places in the ancient world five to ten thousand years ago. At that time it is estimated that the population of human beings on the earth was on the order of one or two million. One or two million people scattered sparsely and unevenly over five continents and thousands of fertile islands. Much less than one person per square mile.

hunting and gathering societies

As always happens in natural ecosystems, there was a rough balance of resources to populations. Humans lived by hunting, fishing and by gathering wild foodstuffs. The average life expectancy was around twenty-five years, just long enough to reproduce and to nurture new human beings before they had to manage the same for their offspring. Since food and living space (in suitable caves and other natural shelters) were always scarce, populations were kept steady as the high birth rate was equal to the high death rate.



learning to do more with less

Then, no one knows for certain how or why, in certain parts of the world, humans learned how to make better use of natural resources. They learned how to multiply natural resources. They learned how to grow crops instead of just find and collect them. They learned how to herd and husband animals instead of just hunt them.

agricultural revolution

In the fertile crescent around the Mediterranean Sea, in the rich river valleys of China, Africa, South America and India, the agricultural revolution

led to the first examples of human civilization, as we would come to call it in later years.



Note that the earth itself had not changed. There was still the same air,

earth and water. Still the same elements as there had been millions, billions of years before. What had changed, though, were the *natural resources* available to human beings. Suddenly there was a substantial increase in resources like food, animal-derived clothing and building materials. And new energy in the form of animal-harnessed muscle power.

population multiplies

Population increased dramatically, multiplying by ten and then a hundred times in just a few centuries. Life expectancy also increased to over thirty years. And though most people were peasants, laborers, serfs or even slaves, they did have a more secure and resource-rich life than their hunting-and-gathering ancestors.

new energy technologies

When the sailing ship was invented to tap the energy of the wind for transportation, population

and resources took another surge forward. Humans could now transport materials much more easily permitting one area to specialize in food production, another in metal smelting and a third in ship-building. And all



could now trade, gaining what they had not, selling what they had too much of.

ancient civilizations

Still more important—and critical to our story—humans could travel more and learn more, one from one another. The high civilizations of Egypt, Mesopotamia, India, China, Southeast Asia, Africa, Greece and Rome were born.

progress in China

In China especially, remarkable progress was made in technology and science. The wheelbarrow, the compass, the printing press and gunpowder—even the first scientific instruments to measure earthquakes—were all invented centuries before they were discovered in the West.

progress in the Middle Ages

In the West, in Middle Age Europe, increases in natural resources came from new technology. The supply of food and energy increased as people



learned to make new kinds of wind and water machines, new methods of soil cultivation, crop rotation and better plows and horse collars. All these led to a gradual betterment of human life as continent Europe was slowly transformed from a primeval wilderness into a human-molded landscape.

the Black Death

Unfortunately, disease acted as a constant brake on human progress during these times. The population of Europe was cut by a third more than once by a plague called the Black Death. In spite of this, however, life expectancy did slowly increase. The population in Europe in 1500 was double the population in 600 when the Roman Empire was in its dying days.

wealth is gold

Throughout these precarious days, as well as all the way back through ancient civilizations, certain ideas about wealth were widespread and deeply ingrained. One of the most influential of these ideas—and one that has lasted right on down to our own times—was that the most important, secure and real form of wealth was gold.

a zero-sum economy

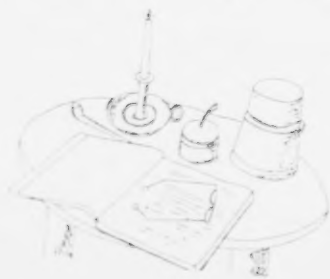
It was understandable. Change was slow. Society, indeed the universe itself, was looked on as a closed, static system. Everyone and everything had its place. If one person was to gain wealth, another must lose wealth. In later times this would be called a *zero-sum* economy.

In such an economy one would be wise to gather and hold onto the most solid kind of wealth. The kind that did not change and was easy to guard and preserve. Of all the natural resources, gold met those tests better than any other.

an open society

In the next three centuries the scientific and industrial revolutions burst upon the western world and changed forever this equation. Suddenly

there was tremendous reshuffling and recreation of natural resources. And a new idea came into the world. The idea of an open society, an open universe. To get wealth you did not have to take it from someone else. You could make it from scratch! People began to have a new vision of progress!



all could be wealthy

Wealth need no longer be held by the tiny one percent of the population while the other ninety-nine percent were condemned to life-long poverty. It was no longer a zero-sum game. All could have

enough. All could someday be as wealthy as the privileged few were today.

new resources

One particular resource in the ground, coal, and one particular resource of human invention, the steam engine, are given much of the credit for the early industrial revolution. Coal had been known from ancient times, but only sparingly used. With the invention of the steam engine, however, this black rock suddenly became a very valuable natural resource. And the way was open for a vast increase in human wealth.



more new resources

After coal came the internal combustion engine and oil and gas as a power source. This was followed by electricity, nuclear energy, computers, much more efficient transportation and communication systems, all the technology that powers and supports our modern twentieth century world.

democracy and capitalism

Just as important as the science and technology were new ideas about the economy and the political organization of society. Liberal democracy and free market capitalism in particular, were opening the eyes of people in Europe and North America to vast new potentials for change, for growth, for progress toward new wealth, power and knowledge.

rapid progress

And change there was. Since our own country was founded in 1776, the population of the world has leaped from three hundred million to close to five billion. Life expectancy has also increased from thirty-two to fifty-five years for the world as a whole. To seventy-four years for the industrialized western world.

The average worker in 1700 could produce \$250 worth of goods a year. By 1984 the figure for the industrialized world had increased to \$5000.

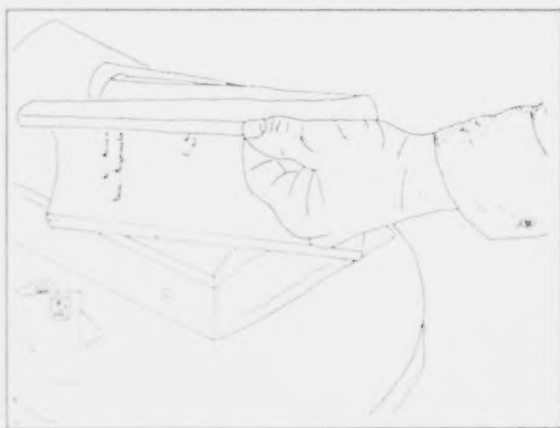
The average farm family in 1700 could feed itself and half a person more. The average farm family in 1984 could feed itself and fifty people more.

Put still another way, in our day every person in our country has the energy equivalent of over one hundred slaves at his or her command.

where from?

If the natural earth has not changed, where has all this new wealth come from?

Answer. From the human hand and mind. From learning how to do more with less.



For remember, the earth is still the same. Or is it?

the disputes

Now we come to the disputes. Yesterday and today. Have we, in the process of industrializing and multiplying our wealth and populations, robbed the earth of her natural wealth? Are we laying the foundations for a terrible catastrophe in the future? One that our children and grandchildren will never forgive us for.

Have we of the wealthy nations gained our wealth by stealing it from the poor nations?

Experts disagree about these questions. As do citizens.

pessimists and optimists

Back in the last century, some of the first serious attempts were made to study the problems of natural resource depletion. Despite the statistically improving life spans and personal incomes, people could see the reality of urban poverty, of child labor, or increasing sanitation and pollution problems. Then, as now, there were pessimists and optimists.

Thomas Malthus

The pessimists took much of their gloomy arguments from an English thinker, Thomas Malthus. Malthus (whose father ironically enough was a famous optimist) wrote an "Essay on Population" in 1798

that became very influential. His argument was simple and apparently irrefutable. Population, said Malthus, always had and always would tend to grow geometrically. While food supply (and all the other raw materials needed for human life) could only be ex-



panded arithmetically. In other words, people multiply, while resources grow only by addition.

the misery of overpopulation

The result, said Malthus, was misery. The only ways food and population could be kept in balance were war, disease and famine. Later he admitted that controlling births might also work, but he doubted this could ever be done.

Darwin and evolution

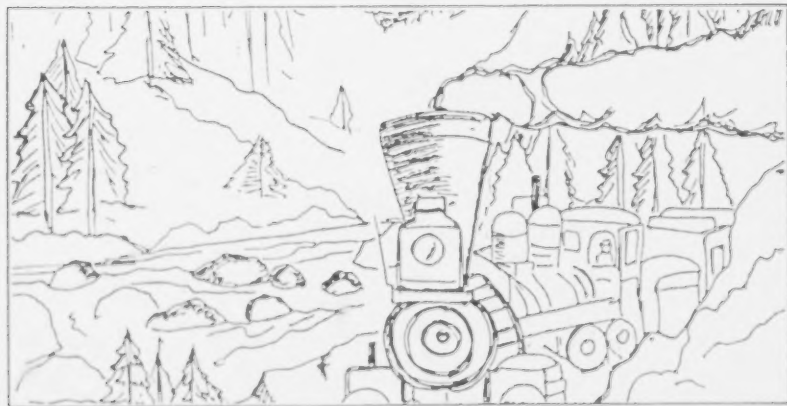
Darwin later used the arguments of Malthus as key points in his own theory of evolution by natural selection.

conservation movements

In the middle of the nineteenth century men like Henry David Thoreau, John Burroughs and John James Audubon tried to alert the public to the alarming speed at which wilderness was disappearing in this country. To the growing scarcity of species like the passenger pigeon, the buffalo and mountain lion. Presidents like Theodore Roosevelt led conservation movements that established our first national parks and forests.

Manifest Destiny

In this same nineteenth century we also had the coming of the lumbermen and miners, the whaling ships and cowboys. All intent on exploiting for human gain the natural resources of a vast continent. On the whole these pioneers tended to be optimists. It was our *Manifest Destiny* to conquer and civilize the North American continent from the Atlantic to the Pacific.



**anti-
wilderness**

Wilderness was often seen as the enemy. It could never be depleted. The frontier was open, opportunities were unlimited, the way was clear for such progress that the kingdom of heaven itself would soon be founded on this glorious continent.

Both points of view have survived and developed since that last century. On the one hand we have expanded the frontier as the optimists predicted, though not quite in the way they imagined.

For instance:

more forests

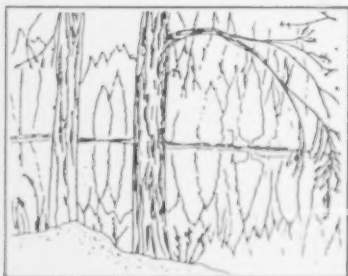
Today, despite the rapid depletion of the original hardwood and pine forests, we produce more wood and forestry products than ever before by a large measure.

more metals

Today, despite the rapid depletion of early easy-to-find-and-mine iron, copper and coal resources, we produce more iron, copper and coal than ever before by a large measure. And at a lower cost in both money and human lives.

more conservation

On the other side, we have also made much progress in conservation. Despite the growth of the lumber industry, for example, we have more forested land today in this country than we had a hundred years ago! Despite the depletion of the original hematite iron ranges, new technologies of taconite processing have given us more iron ore today than we had a hundred years ago! Over and over again we have learned to do more with less.



paradoxes

These paradoxes—the more we use, the more we have left—as well as our increasing ability to do more with less, have misled many experts in the past. As a result their predictive accuracy has not been impressive.

predictions about oil

In 1908, for instance, the U.S. Bureau of Mines predicted a total future world supply of oil of 22.5 billion barrels. (The world has used one and a half

times that much since 1908, and now has over 26 billion barrels in proven reserves!)



By 1939 officials were predicting the U.S. oil supplies could last only another thirteen years. By 1949 they saw the end of the oil supply in sight.

And as recently as 1979 President Jimmy Carter declared the imminent oil shortage a national crisis of survival dimensions.

predictions about population and food

A similar story could be told of predictions of imminent food shortages and worldwide famine. In 1969 a prominent expert, Dr. Paul Ehrlich, wrote a best-selling book, *The Population Bomb*. In the first sentence he claims, "We have already lost the battle. No matter what crash programs are instigated at this time, they will not be enough to prevent a worldwide famine of catastrophic proportions in the next ten years. Billions of people will die."

what happened?

What actually happened? Now, *twenty years later*, there have been no worldwide famines. In fact, life expectancy is up all over the world. The food supply has more than kept pace with population growth even in the poorest countries. And all this has been accomplished without any crash programs. Just ordinary progress. Steady continuous

application of human kind's incredible ability to do more with less.

Club of Rome

In 1972 a group called the Club of Rome sponsored two studies of natural resources for the future using computer simulations. Their conclusions were similar to those of past doomsday experts. The world has not much further to go before we run out of the basic raw materials we need to support our civilization.

Global 2000

In 1980 a U.S. government-appointed study group issued a report, *Global 2000*, that echoed much of the doomsday vision of the Club of Rome.

Three years later, however, another group of twenty-one experts reported to the annual convention of the American Association for the Advancement of Science a totally opposite report, *The Resourceful Earth: A Response to Global 2000*.

These experts claimed that, contrary to the Club of Rome and to the popular belief in recent years, the world by the year 2000 will be less crowded, less polluted, have more food per capita and more natural resources per capita than ever before

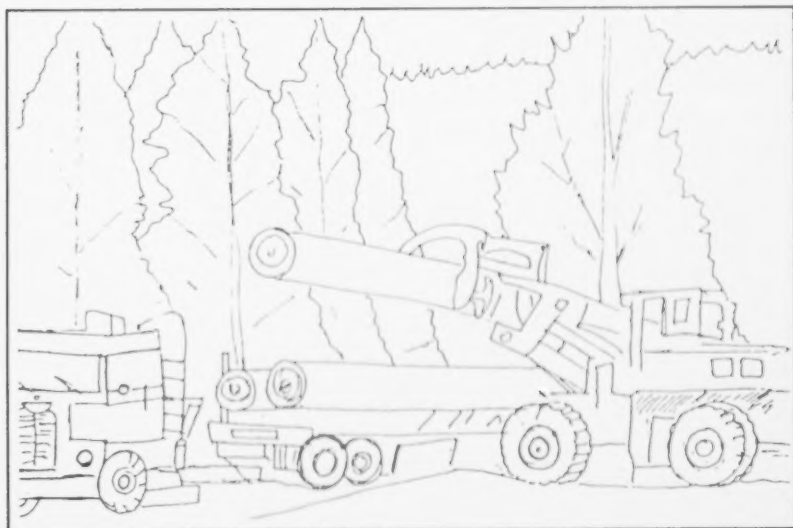
who is right?

Who is right? *Global 2000* or *The Resourceful Earth: A Response to Global 2000*?



Read on to the second part of this book where we will examine in detail the two scenarios for the future. Doomsday or Utopia?

Part 2: Utopia or Doomsday—Present and Future



on using natural resources

You have probably heard the statement made that the United States with six percent of the world's population uses over forty percent of the world's resources and generates over sixty percent of its wastes.

The question is—is this something to be ashamed of or proud of?

what is a natural resource?

The answer you give depends a good deal on your understanding of just what a natural resource is. Let's consider that question first.

On the surface it looks easy enough. Oil, gas, coal; soil, air, water; minerals, wildlife, wilderness. All these and more are indeed natural resources. Just as litter, trash, smoke, toxic wastes, radioactive particles are pollutants. If you look closer, however, it gets more complicated and interesting.

**wastes can be
resources**

Geologically speaking, coal, oil and gas are themselves the waste products of ancient plants and animals. And closer to our time, waste paper can be a natural resource for recycled paper; radioactive wastes can be a natural resource for breeder fuel; broken bottles and discarded plastics can be natural resources for new glass and new plastic.

**is mold a
resource or a
pollutant?**

Then, too, there is the matter of what we know or don't know. Coal, oil and gas have been in the ground for hundreds of millions of years, but only very recently have they been worth digging or pumping up. Rocks from the northern shore of Lake Superior were never considered a natural resource until someone figured out there was iron in them. Cantaloupe mold was considered a pollutant until someone figured out there was penicillin there, and it could be used to cure infections.

**knowledge as
key ingredient**

In other words, being a natural resource has much to do with the state of human knowledge and ingenuity at any given time. What was an important resource yesterday (whale oil, for instance, or



beaver fur) is no longer considered an important natural resource today. Not because there are fewer whales or beavers, but because the same human needs are now being met more cheaply, effectively and efficiently by petroleum and nylon.

Let's put it this way. There are three things necessary if we are to have a natural resource.

**three require-
ments**

One. There must be a human need, a demand for a particular service or commodity.

Two. There must be a physical thing that can be found or made to satisfy that need.

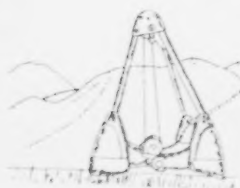
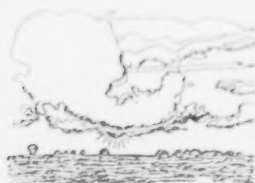
Three. There must be available the human knowledge and skill to do the job—transforming the physical thing of matter and energy into the human thing of value.

energy resources

Take an example. (1) Humans need and want energy and power. (2) There exist in the world physical things that have the potential to provide useful energy and power. (3) Humans have figured out some ways to tap some of these sources of energy and power for their own purposes.

unknown twenty years ago

Notice that I said some of these sources. By no means all, nor even necessarily any high percentage of these sources. We do know of some ways to get energy from nature. Oil, gas, coal; water flowing, wind blowing, sunlight shining; atoms splitting, tides moving, rocks underground heating. Most of these ways were totally unknown two hundred years ago. Many were not known twenty years ago.



**twenty years
from now?**

And what will we know twenty years from now? A hundred years from now? It would be a rash person to claim to know.

Consider some possibilities already on the way. Fusion power, vast untapped solar power, nuclear breeder power, vastly improved efficiencies in all our machines, power from fuels in outer space—we know not how many possible other sources, totally unsuspected at the moment.

**will we ever
"run out?"**

In other words, it is highly unlikely, if the past is any judge at all, that we will ever "run out" of energy resources. Our ingenuity has already created far more choices than we can use efficiently.

raw materials

So, too, with raw materials. Beaver fur is replaced by nylon. Whale bone is replaced by plastic. Copper wires are replaced by glass fibers and satellite disks.

When you consider how young we are as human beings on this earth, we have barely begun our search.

**knowledge is
the key**

The search is the key. In the end it is not physical things that limit us. In truth the only real natural resource we need to worry about is the ultimate resource—the human hand and mind.



**from natural
resource to a
thing of beauty**

When we put our minds and hands to it, look what we can create.

The natural resource of hard rock is transformed into a transistor, a silicon chip, a sculpture.

The natural resource of soft wood is transformed into a pencil, a table, a book.

The natural resource of air and water is turned into fertilizer, into corn, into a gourmet meal.



but wait ...??

People who say we are fast running out of natural resources; people who say the United States should be ashamed of itself for squandering such a large proportion of the world's resources; people who say we are heading for a doomsday reckoning might reply ...

a finite world

"While all you say may have been true in the past, the situation is drastically changed today. Despite efficiency and the power of the mind and all that—the world, you see, is finite. There is only so much air, soil and water; only so much oil, gas and iron and copper to go around. If we use more than our



share at this late date in human history, the rest of the world, and our own children will be the poorer for it. Especially considering the way the population of the world is exploding!"

**"more crowded,
ed, more polluted ..."**

As the presidential commission *Global 2000* reported in 1980, "if present trends continue, the world in 2000 will be more crowded, more polluted, less stable ecologically, and more vulnerable to disruption than the world we live in now."

**"less crowded,
less polluted ..."**

Three years later, however, another group of scientists published *The Resourceful Earth: A Response to Global 2000*. They came to the exact opposite conclusion. "If present trends continue, the world in 2000 will be less crowded, less polluted, more stable ecologically, and less vulnerable to disruption than the world we live in."

How could two groups of professional scientists come to such diametrically opposed conclusions?

**Is wealth the
gold in Fort
Knox?**

Here is one possible answer. If you look on natural resources as simply and only physical oil in the ground, physical square miles of soil and



oceans of water and air. If you view wealth as the gold buried in Fort Knox, then yes, the world is finite. More people will indeed need and use more. And what we use someone else must do without. And the more we use the more wastes we will create, and thus the world will end up

more polluted, more disrupted and less stable.

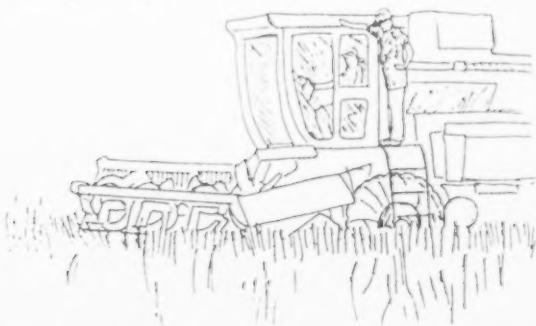
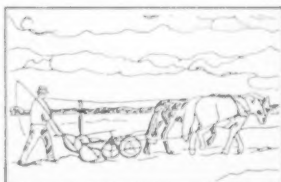
**add the human
hand and mind**

However, once you add the human mind to the equation, it changes radically. In this view, a natural resource is only a resource if human needs and

ingenuity make it so. And since by far the most important part of any natural resource is this human ingenuity and skill, we have learned in the past and we can learn in the future to multiply resources faster than we multiply people.

**more food on
less soil**

The same soil, for instance, that once supported three people now supports three hundred. How? Because we have learned how to breed better seeds, add better fertilizer, cultivate more efficiently, and distribute the food more efficiently and equitably.



**more
messages
using less
material**

The same copper that once carried ten telephone messages now carries ten thousand because we learned how to multiply electromagnetic carriers, to pack more information into smaller spaces. And tomorrow we can send ten million messages using no copper at all, just glass fibers and satellites in space.

**looking at the
record**

Let's look at the record, say the *Response to Global 2000* scientists. Population has grown by leaps and bounds in the past century, it is true. But food supply has grown even faster. Yes, even in the poor countries of the world, most of whom are now self-sufficient and even exporting food.



The same goes for life expectancy, infant mortality, health, communication, education. Much of the world is still below the standards of North America, Europe and Japan but, despite the gloomy reports, there is and has been consistent progress over the

past decades. If natural resources were fixed and limited, where did all this new growth, this new wealth, come from?

**producing
more than its
share**

The United States with only six percent of the world's population has not been stealing more than its share. It has been creating more than its share!

Thankfully the rest of the world is catching on, and beginning to create more wealth for itself. For wealth is not gold. It is knowledge. Knowledge that brings power and delight.

**will process
continue?**

This being so, despite temporary setbacks, there is no reason to think the process of creating wealth will not continue. Population will level off as it always has in past revolutions. We will attain a new equilibrium more desirable than any in the past.

**future of an
open society**

In other words, resources are not finite after all. The future, in this view, is open, is unlimited, is full with risk, challenge and potential. Because the human mind is open, is unlimited, is full with risk, challenge and potential.

**problems for
the future**

But wait, you say! Not so fast. What about pollution? What about acid rain, the greenhouse effect? What about over-population, species extinction? There have to be limits somewhere. The world is not a commodity to be processed by man alone. It is a community to which we belong as one and

only one member. We must pay heed. We must strive for quality as much as for quantity. As Henry David Thoreau once wrote, "I hear they are planning to build a telegraph from Maine to Texas, but I wonder whether anyone has enquired whether Maine and Texas have anything important to say to one another."

To which all intelligent people must respond, yes. We must pay heed. That is what being human is all about.

**a partnership
with nature**

True, we must begin to look on ourselves as a partner in nature, not as a tyrant. True, we must consider quality as well as quantity. The quality of what we say and think and do is ever so much more important than how fast or how many things we do and say.

**a new
consensus**

And there is slowly growing a new consensus among the world's peoples. It needs nurturing the way any new crop does. But it is gaining strength all the time and will continue to do so.

This new consensus says things like:

**pollution can
be controlled**

Pollution can and will be controlled. Even more, pollution can and will be turned to the good of the whole living planet.



One example: in north-central Illinois they are right now using waste sludge from Chicago's sewage system to rehabilitate strip-mined land, turning it back into productive corn fields and orchards.

species can be protected

Species can and will be protected. Including all varieties of our own species, *Homo sapiens*.

Example: in Wisconsin Siberian cranes and whooping cranes are being raised in captivity to help increase the population in the wild and to understand how to save the natural habitat of wild cranes. We are also learning also how to preserve and expand natural wilderness areas. Even how to bring back to a natural state areas formerly polluted.

wealth for the world can be increased

But the new consensus also demands that while we are preserving and enhancing our natural environment, at the same time we increase our worldwide ability to create new wealth so that ...



100% of the world's people eat well every day.

100% of the world's people have good housing.

100% of the world's people have good health care.

100% of the world's people have the freedom to make choices, the freedom to

search, the freedom to learn, the freedom to create wealth themselves and in the process to create a better life for themselves and for their children and their children's children.

we had better get busy

Which is, after all, what natural resources are all about. We had better get busy. Doomsday has been cancelled. Utopia is irrelevant. The future is what we make it.

TIME ...

To understand the world of today it helps to know something about the world of yesterday. Kings and queens, wars and famines, presidents and paupers have all played a part. But more important than any of these in changing the past world into the world of today has been science and technology. The time line below will help you place important events and people in historical time.

<u>EVENTS IN WORLD HISTORY</u>			<u>EVENTS IN SCIENCE & TECHNOLOGY</u>
600-300 B.C. Golden Age of Greece	500 B.C.	500 B.C.	agricultural revolution began 8000-10,000 B.C. (World population, 5 million)
Birth of Christ	A.D. 1	A.D. 1	600 B.C. to A.D. 1800 sailing ships multiply natural resources
200 B.C. to A.D. 450 Roman Empire			
	500	500	
500-1300 The Middle Ages			500-1300 advances in technology, including horse collars, windmills & waterwheels (world population, 200 million)
	1000	1000	
1400-1700 Renaissance			1400-1700 modern science begins with Galileo, Newton and others (world population, 500 million)
1776 Declaration of Independence	1500	1500	
1900-today Industrial Revolution			1800-present Industrial Revolution
	2000	2000	

EVENTS IN WORLD HISTORY

1776
American Revolution
(population:
U.S., 4 million
world, 600 million)

1861-65
Civil War in U.S.
(population
U.S., 36 million
world, 1 billion)

1914-18
World War I

1929-38
economic depression
(population:
U.S., 120 million
world, 2 billion)

1939-45
World War II

1950-52
Korean War

1966-73
Vietnam War
(population:
U.S., 210 million
world, 4 billion)

EVENTS IN SCIENCE & TECHNOLOGY

1774
James Watt invents steam
engine

1820-1840
whale oil & whale bone
major natural resources

1840-1860
Industrial Revolution
expands rapidly in England,
Europe and North America:
average farm family can
feed five people

late-1800s
coal and iron major natural
resources for industrial
revolution

1880
Edison's first electric light

1908
Ford brings out Model T

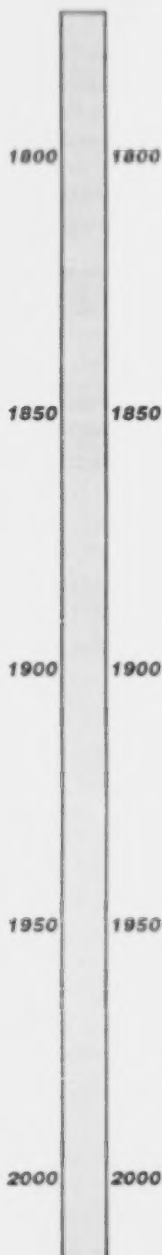
1920s
Oil and gas replace coal as
#1 energy source

1941
first nuclear reactor

1960
photovoltaic cells cost
\$100 per kwh

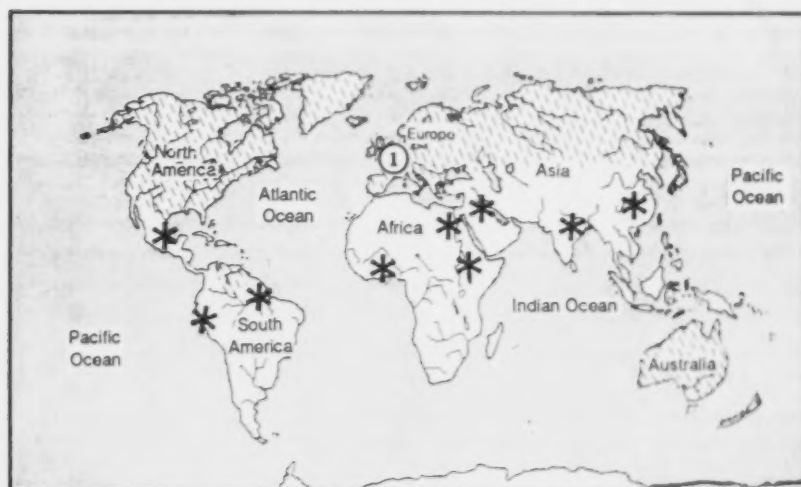
1980
2 percent of Americans live
on farms: average farm
family can feed 50 people

1990
photovoltaic cells cost 13
cents per kwh



SPACE ...

There is a saying, "If you don't know where you are going, any road will get you there." One of the important parts of knowing where you are going is a knowledge of geography. The map below will help you to locate the important events and people discussed in this book.



1. Industrial Revolution, beginnings

England and northern Europe, where the Industrial Revolution began in the late eighteenth and early nineteenth centuries.

 **Industrial Revolution, 1990**

The Industrial Revolution in 1990. Areas where more than fifty percent of the people work in nonagricultural occupations and with per capita income of over \$2500 U.S. dollars. (Does not include some areas in the middle east where per capita income is over \$2500 due to oil-export, but countries are still preindustrial.)

*** Agricultural Revolution**

Centers for the expansion of natural resources in the agricultural revolution. Humans learned to grow food and husband animals six to ten thousand years ago.

SPIRIT ...

Time and space are meaningless without spirit. Spirit is the part in each of us that understands. The part that sees connections between words and things—connections that surprise and make sense. Study the key words, concepts and ideas below so that you can understand how time, space and spirit worked in the past—and are working today.

acid rain

Rain that has sulfur and nitrogen oxides dissolved in it. Known to damage forest and lake ecosystems. (p. 21-23)

agricultural revolution

A time four to eight thousand years ago when many societies learned how to grow crops and husband animals. The beginning of ancient civilizations. (p. 4, 25)

coal

A black rock found in many deposits throughout the world. The basic energy source for the industrial revolution and still important today. (p. 7, 15)

democracy

A form of political organization that values individuality, constitutional rights and equality of opportunity. Along with capitalism, important in providing a base for scientific and industrial revolutions of nineteenth century in Europe and North America. (p. 8)

doomsday

A belief popular in many ages that the world is rapidly heading toward catastrophe. (p. 1, 23)

ecosystem

In nature a collection of living plants and animals and the environment they live in. (p. 3)

energy resources

Ways of getting work done. Can range from muscle power of people and animals to fossil fuels, sunlight, nuclear, tidal, geothermal, etc. (p. 17)

fossil fuels

The remains of ancient prehistoric plants and animals, now found as coal, oil and gas. Used

	for energy and as a raw material for many chemicals in modern societies. (p. 8-9, 11)
greenhouse effect	When the percentage of certain gases—especially carbon dioxide—increases in the atmosphere, causing a warming trend. (p. 21-23)
industrial revolution	The very great changes in human life brought about by modern science and technology in the nineteenth century. Began in England but quickly spread throughout Europe and North America, and is now rapidly spreading throughout the world. (p. 6-8)
infant mortality	A statistical measure of how many infants survive the first year of life. One indicator of the comparative health of a community. (p. 20)
life expectancy	A statistical measure of how long, on the average, a person can expect to live in a given society. One indicator of the comparative health of a community. (p. 4, 8, 20)
Malthus, Thomas	An English economist and philosopher who wrote an influential "Essay on Population" in 1798. (p. 10)
natural resources	See this book. Especially pages 15-16.
overpopulation	When the population of any given species becomes larger than the ecosystem can support. Controversial when applied to human populations today. (p. 21)
pollution	Unwanted matter or energy that causes harm to living ecosystems. (p. 9, 14, 21-22)
solar energy	Energy from sunlight. It can take many forms, such as solar heat panels, solar voltaic cells, photosynthesis, biomass, etc. (p. 2, 16)
solar voltaic cells	Thin cells made primarily of silicon that can directly convert sunlight into electricity. (p. 25)

**species
extinction**

When a particular kind of plant or animal can no longer live and reproduce on earth. Examples in the past include dinosaurs and trilobites. Today there is concern about human development and pollution causing rapid extinction of many species. (p. 21, 23)

technology

The use of skill and knowledge to invent, produce and operate useful machines, and devices for the benefit of human life. (p. 8)

utopia

An imaginary state of society where everything is wonderful. (p. 1, 23)

wilderness

A natural area undisturbed by human activities. (p. 23)

zero-sum

A theory of economics in which every gain by one person must be balanced by a loss by someone else. (p. 6-7)

In addition to the above, *Natural Resources* also teaches about other important people, places, things and ideas. Often you can figure out the meaning of a new term by seeing how it is used in context. Make sure you know the meaning of the following (for help, check the pages listed in this Learning Power Book, as well as your dictionary and encyclopedia):

Africa (p. 4-5); Black Death (p. 5); capitalism (p. 8); Carter, Jimmy (p. 12); China (p. 4-5); Club of Rome (p. 13); Egypt (p. 5); Ehrlich, Paul (p. 12); Fort Knox (p. 19); geothermal (p. 17); *Global 2000* (p. 13, 18); Greece (p. 5); hematite (p. 11); Middle Ages (p. 5); *Resourceful Earth: Response to Global 2000* (p. 13, 19-20); Roosevelt, Theodore (p. 10); silicon chip (p. 18); steam engine (p. 7); taconite (p. 12); Thoreau, Henry David (p. 10, 22); underdeveloped world (p. 23).

STUDY SUGGESTIONS ...

1. Many people have accepted uncritically the view that the world is overpopulated, becoming more polluted all the time and fast running out of natural resources. Choose a particular energy source (coal, oil, nuclear power, etc.) or a particular material (food, iron, copper, paper, etc.). Investigate its cost, availability and use at different times in the past. Do this for the world as a whole or for one particular country. See if you can find any correlations to population growth and/or environmental degradation. You can get data and arguments on both sides from books listed in the bibliography below, particularly *Global 2000* and *The Resourceful Earth: A Response to Global 2000*. Discuss and debate in class.

2. How crowded is the world? Use any good world almanac and do the following exercises. If all of the people in the world were living next door to one another in houses or apartments like yours, how much space would be needed? If all of the world's people were to attend a rock concert, how many acres (or square miles) would you need? What would be the population density of the United States if all the people of China and of India were to move here?

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Malthus, Thomas R. *Essays on Population*. Includes essays by Julian Huxley and Frederick Osborn. New York: New American Library, 1960.

Simon, Julian. *The Ultimate Resource*. Princeton, NJ: Princeton Univ. Press, 1981.

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Wattenburg, Ben J. *The Good News Is the Bad News Is Wrong*. New York: Simon & Schuster, 1984.

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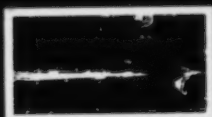
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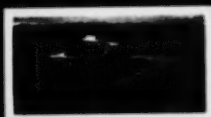
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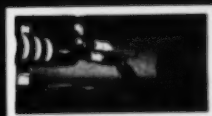
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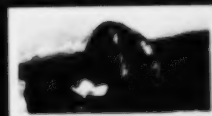
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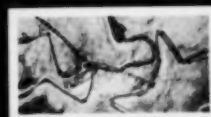
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Evolution



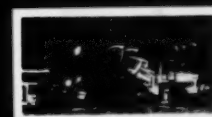
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The Gene



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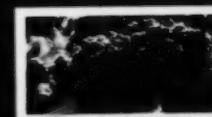
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Radiation



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